

AMENDMENT UNDER 37 C.F.R. § 1.111
U. S. Application No. 09/783,135

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (original): A method for indexing feature vector data space comprising the step of:
- (a) adaptively approximating feature vectors on the basis of statistical distribution of feature vector data in the feature vector data space.
2. (original): The method of claim 1, wherein the step (a) further comprises the steps of:
- (a-1) measuring the statistical distribution of the feature vector data in the feature vector data space;
- (a-2) estimating marginal distribution of the feature vector data using the statistical distribution;
- (a-3) dividing the estimated marginal distribution into a plurality of grids in which a probability of disposing the feature vector data in each grid is uniform; and
- (a-4) indexing the feature vector data space using the divided grids.
3. (original): The method of claim 2, further comprising prior to step (a-4), the step of updating the grids on the basis of a previous probability distribution function and an updated probability distribution function, when new data is received.
4. (original): The method of claim 2, wherein step (a-4) further comprises indexing using vector approximation (VA) files.

5. (original): The method of claim 2, wherein a number of the plurality of grids is determined by a number of bits assigned to the dimension.

6. (original): The method of claim 2, wherein step (a-2) further comprises the steps of:

(a-2-1) defining a probability distribution function using a weighted sum of a predetermined distribution function; and

(a-2-2) obtaining an estimated probability distribution function by estimating predetermined parameters using the probability distribution function defined in the step (a-2-1).

7. (original): The method of claim 6, wherein step (a-2-2) further comprises obtaining the estimated probability distribution function by estimating the predetermined parameters using all N predetermined data in each estimation, wherein N is a positive integer, on the basis of an expectation-maximization algorithm using the probability distribution function defined in the step (a-2-1).

8. (original): The method of claim 6, wherein the predetermined distribution function is the Gaussian function.

9. (original): The method of claim 6, wherein the probability distribution function of step (a-2-1) is a one-dimensional signal, $p(x)$, wherein $p(x) = \sum_{j=1}^N p(x|j)P(j)$, and wherein $p(x|j)$ is defined as

$$p(x|j) = \frac{1}{\sqrt{2\pi\sigma_j^2}} \exp\left\{-\frac{(x - \mu_j)^2}{2\sigma_j^2}\right\},$$

wherein coefficient $P(j)$ is a mixing parameter that satisfies the following criterion

$$0 \leq P(j) \leq 1 \text{ and } \sum_{j=1}^M P(j) = 1.$$

10. (original): The method of claim 6, wherein the estimated probability distribution function of step (a-2-2) is obtained by finding $\Phi_j, j=1, \dots, M$, which maximizes

$$\Phi(\Phi_1, \dots, \Phi_M) = \prod_{l=1}^N P(v[l] | (\Phi_1, \dots, \Phi_M)), \text{ where parameters } v[l], l=1, \dots, N, \text{ is a given data set.}$$

11. (original): The method of claim 10, wherein the estimated parameters of step (a-2-2) are updated according to the following equations

$$\mu_j^{t+1} = \frac{\sum_{l=1}^N p(j|v[l])^t v[l]}{\sum_{l=1}^N p(j|v[l])^t},$$

$$(\sigma_j^2)^{t+1} = \frac{\sum_{l=1}^N p(j|v[l])^t (v[l] - \mu_j^t)^2}{\sum_{l=1}^N p(j|v[l])^t}, \text{ and}$$

$$P(j)^{t+1} = \frac{1}{N} \sum_{l=1}^N p(j|v[l])^t, \text{ wherein } t \text{ is a positive integer representing a number of}$$

iterations.

12. (original): The method of claim 11, wherein the estimated parameter set of step (a-2-2) using N data $v[l]$ is given as $\{P(j)^N, \mu_j^N, (\sigma_j^2)^N\}$, and the updated parameter set for new data $v[N+1]$, coming in, is calculating using the following equations:

$$\mu_j^{N+1} = \mu_j^N + \theta_j^{N+1} (v[N+1] - \mu_j^N),$$

$$(\sigma_j^2)^{N+1} = (\sigma_j^2)^N + \theta_j^{N+1} [(v[N+1] - \mu_j^N)^2 - (\sigma_j^2)^N],$$

$$P(j)^{N+1} = P(j)^N + \frac{1}{N+1} (P(j|v[N+1]) - P(j)^N), \text{ and}$$

$$(\theta_j^{N+1})^{-1} = \frac{P(j|v[N])}{P(j|v[N+1])} (\theta_j^N)^{-1} + 1.$$

13. (original): The method of claim 11, wherein the step (a-2-2) further comprises:
measuring a change of a probability distribution function which is defined as

$$\rho = \frac{\int (\hat{p}_{old}(x) - \hat{p}_{new}(x))^2 dx}{\int \hat{p}_{old}(x)^2 dx} \text{ for each dimension, wherein a previous probability distribution}$$

function is $\hat{P}_{old}(x)$, and an updated probability distribution function is $\hat{P}_{new}(x)$; and

updating an approximation for the dimension if ρ is larger than a predetermined threshold value.

14. (original): The method of claim 2, wherein step (a-3) further comprises dividing a probability distribution function into the plurality of grids to make areas covered by each grid equal, wherein the plurality of grids have boundary points defined by $c[l]$, $l = 0, \dots, 2^b$, where b is a number of bits allocated and wherein the boundary points satisfy a criterion,

$$\int_{c[l]}^{c[l+1]} \hat{p}(x) dx = \frac{1}{2^b} \int_{c[0]}^{c[2^b]} \hat{p}(x) dx, \text{ and wherein the estimated probability distribution function is}$$

$\hat{p}(x)$.

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15. (new): The method of claim 1, wherein the feature vector data space is in a plurality of dimensions and the feature vector data is in one dimension.

16. (new): The method of claim 2, wherein the feature vector data space is in a plurality of dimensions and the feature vector data is in one dimension.
